acid—gives the corresponding *ortho-amidophenylacetic acid*,

$$(C.)\quad C_6H_4\langle{}^{CH_2.COOH}_{NH_2}.$$

In a neutral solution this acid is changed into its anhydride by the elimination of a molecule of water forming

$$(D.)\quad C_6H_4\langle{}^{CH_2.CO}_{NH}\rangle.$$

And here we leave the long names indicative of the structural composition of the compounds: for Prof. Baeyer has found that this anhydride is identical with oxindol, one of the derivatives of indigo. The next steps are to introduce the nitroso group, NO, forming *nitroso-oxindol*,

$$(E.)\quad C_6H_4\langle{}^{CH(NO).CO}_{NH}\rangle,$$

and to reduce this as before to *amido-oxindol*,

$$(F.)\quad C_6H_4\langle{}^{CH(NH_2).CO}_{NH}\rangle.$$

This compound, when oxidised with chloride of iron or copper, or with nitrous acid, is changed entirely into *isatin*,

$$(G.)\quad C_6H_4\langle{}^{COCO}_{NH}\rangle,$$

a substance resulting from the oxidation of indigo, which already in 1870 Prof. Baeyer, by the action of phosphorus trichloride, had changed back into *indigo-blue*,

$$(H.)\quad \begin{array}{l} N.C_6H_4.CO.CH \\ \| \qquad\qquad\quad \| \\ N.C_6H_4.CO.CH \end{array},$$

by the union of two molecules and the elimination of two atoms of oxygen. With this last transformation the synthesis was completed. Although the operations are too numerous and too costly to allow at present any hope of the practical utilisation of this ingenious succession of reactions, the series presents still a remarkable example of the possibilities in the hands of the organic chemist, of the powers of combination requisite for the successful pursuit of modern synthetical research, and of the attractions which draw to this province the majority of our leading chemists. T. H. N.

BIOLOGICAL NOTES

THE COMET-FORMS OF STAR-FISHES.—Ernst Haeckel, in a recent number of the *Zeitsch. wiss. Zool.* (1878, Supplement 3), draws attention to these forms, and the support which the facts recently established as to the power possessed by certain star-fishes of multiplying by throwing off their arms, lends to his theory of the origin of the Echinoderma by the continually increasing integration or centralisation of a radially-connected colony of worm-like persons. The phenomenon of self-division across the disc has been observed in species of Asteracanthion (Uraster) by Lütken and Kowalewsky; the production of comet-forms depends, however, on the separation of single arms, which then reproduce the whole disc and remaining arms by budding. Martens, in 1866, observed this in the case of a Luidia (Ophidiaster) in the Red Sea. Kowalewsky found that it was a common process with similar species and same locality. Sars observed it in Brisinga. Studer has described the regular occurrence in Labidiaster of a spontaneous casting off of the arms, but not the regeneration of disc and arms on the separated arms. Sir John Dalyell observed the whole process of reproduction of the disc on a single detached arm of *Asteracanthion* (*Uraster*) *glacialis*. The support which these facts lend to the "Astrocormus" theory is not of that value which Haeckel would assign to them, for such physiological tests of morphological doctrine are necessarily delusive. We have only to remember the facts as to cuttings and graftings in organisms generally in order to see that no special argument can be based upon them as to details of morphological composition. Haeckel proposes to divide the Echinoderms or Estrellæ as follows:—

Group I.—Protestrellæ: Class I. Asteriæ.
Group II.—Anthestrellæ: Class 2. Ophiuræ; Class 3. Crinoida.
Group III.—Thecestrellæ: Class 4. Blastoida; Class 5. Echinida; Class 6. Holothuriæ.

The second and third groups have developed from the first as diverging branches, whilst the Holothuriæ are modified descendants of Echinida. The resemblances between Gephyrea and Holothurians are declared by Haeckel to be entirely due to parallel adaptation (homoplasy), the pair of branched excretory organs of Bonellia, &c., being totally unrelated to the dendriform water-lungs of Holothurians, which are *five* in number in primitive forms and agree with branched inter-radial cœca (not the so-called "hepatic" cœca) of the intestine found in certain star-fishes (Archaster, Astropecten). E. R. L.

THE TRANSFORMATIONS OF BLISTER-BEETLES.—According to Dr. C. V. Riley, who has studied these creatures for some years, the young of all vesicants belonging to the Meloidæ, develop in the cells of honey-making bees, first devouring the egg of the bee and then the honey and bee-bread. They are all remarkable for their hyper-metamorphosis, passing through several larval stages. The young Meloës are at first simple larvæ called triungulins, running actively about, climbing to flowers visited by bees, to which they attach themselves. They have stout thighs and claws, but feeble jaws. Only a few can get attached to the proper bees, the others must perish. Once in the cell the creature eats the bees' egg, and then moults and assumes the second larval condition. In this state it is clumsy and little locomotive, and feeds on the honey store. It then becomes a pseudo-pupa, and later a third larva within the partially-rent skin; the true pupa stage being still later. Another genus of the family is *Hornia*, of which a remarkable species is found around St. Louis, with the elytra and wings extremely reduced. The Hornia resides mostly in the galleries of *Anthrophora sponsa*, out of which it can scarcely crawl. The hyper-metamorphosis is of the same character as in Meloë (*American Naturalist*, April). The genus Epicauta exhibits a very parallel history.

CURIOUS SOCIAL RELATIONS.—Stories about prairie dogs, owls, and rattlesnakes are well known, but trustworthy scientific observations about them are not very numerous. Mr. S. W. Williston (*American Naturalist*, April) gives the results of several years personal observations. He says that prairie dogs can thrive even in the dry scorched deserts of Southern Colorado, and the cold bleak Laramie plains. They are very provident in summer for winter, but yet emerge in spring much reduced in plumpness. At the approach of danger signals of distress are given, and when actually attacked they get into their mounds with wonderful speed, escaping beyond reach even when a rifle has scattered the brains of the animal. The burrowing owl not unfrequently occupies the same hole; the prairie dog pays little heed to it but tolerates it. The owls present a most ridiculous appearance, standing during the day at the entrance of their dwellings, in an attitude of the deepest contemplation; at the appearance of an intruder they begin the most comical bowings and curtsies, and at last with a cry like a watchman's rattle fly off to a neighbouring mound. The rattlesnakes cannot be said to be friendly with either of these creatures. Out of many hundreds of rattlesnakes destroyed by Mr. Williston, a number had devoured the young of the prairie dog, but none the young owl. The occupancy of a burrow by a

rattlesnake does not, however, prevent the entrance of the dog; the rattlesnake is never wanton, and only defends itself and takes necessary food. The dog will pass by it to enter its burrow without being molested.

CLEISTOGAMOUS FLOWERS IN GRASSES.—Mr. C. G. Pringle has discovered in Western Vermont cleistogamous flowers in several grasses, especially *Danthonia spicata*. The latter has many flowers totally concealed in the sheaths, the glumes and pales being much simplified, but the sexual parts being perfect and producing seeds. This plant is spreading rapidly in Vermont. The seeds borne on the top of the culm fall mostly at midsummer and lodge close to the parent plant, but the concealed seeds stored around the culm remain till these are disjointed and driven about by the autumn and winter winds; consequently, a wide means of dissemination is provided.

ON THE VIEW OF THE PROPAGATION OF SOUND DEMANDED BY THE ACCEPTANCE OF THE KINETIC THEORY OF GASES

1. IT is an accepted fact that the molecules of a gas are *in motion* among themselves in their normal state, and incapable of acting on each other at a distance; so that a theory of the propagation of sound, based upon the contrary suppositions that the molecules of a gas are *at rest* in their normal state and capable of acting on each other at a distance, cannot possibly be tenable. It thereby becomes necessary to inquire what view of the propagation of sound is demanded by the acceptance of the kinetic theory of gases; and this inquiry would appear to be all the more important in view of the fact that the mechanism of the propagation of sound in gases forms the physical basis of a great part of acoustics, or the groundwork upon which a number of its problems depend—the *physical basis* that underlies a system being admittedly the most important of the whole.

2. The molecules of a gas being in motion among themselves, it becomes evident after a very brief consideration of the question, that the only way in which a small impulse (or variation of velocity) termed a "wave" can be propagated through a gas, is by the exchange of motion normally going on among the molecules of the gas. *For the molecules have no other mode of acting upon each other, excepting by exchange of motion.* The rate at which this "wave" (or small variation of velocity) is propagated through the gas, will therefore depend on *the rate at which the molecules exchange motion*, i.e. on the normal velocity of the molecules of the gas. The sole condition determining the velocity of propagation of sound in a gas is therefore the velocity of the molecules of the gas. Here, therefore, we have a very simple condition for the velocity of sound (on the basis of the kinetic theory), or the velocity of sound becomes thus dependent only on *one* condition. This simplicity is characteristic of the rest of the kinetic theory, and is (it may be added) the recognised quality of scientific truth. In gases of the most diverse densities, specific gravities, pressures, and temperatures, the velocity of sound is only dependent on *one* condition, viz., *the velocity of the molecules*, of the gas.

3. That the velocity of sound is independent of *density*, will be evident from the consideration that the molecules of gas are almost indefinitely small compared with their length of free path, and also the time of a collision is indefinitely small compared with the time taken to traverse the free path, so that it does not matter how many collisions (or exchanges of motion) occur along the line of passage of the impulse (or "wave"), but simply on the *rate of motion* of the molecules conveying the impulse. So (to take a simple analogy by way of illustration), it does not matter how many couriers are along the line of route conveying a message, but on the rate of motion of the couriers. Adding to the number of molecules in unit of volume of a gas (or adding to the density) does not, therefore, alter the velocity of sound in a gas, because it does not alter the *velocity* of the molecules which (by their exchange of motion) propagate the wave. The old theory supposes that the velocity of sound is here unaltered, because increased density *diminishes* the velocity of propagation of the wave, and increased pressure (attendant on the increased density) *augments* the velocity of the wave, and thus the two conditions counteract each other. On the kinetic theory, neither of these conditions can have any effect, and therefore the explanation of the unaltered velocity of the wave is perfectly simple, being the cosequence of the *unaltered* velocity of the molecules which propagate it. It is unnecessary to comment on the contrasted simplicity of the view on the kinetic theory; which is, moreover, the *true* view, if the kinetic theory be accepted.

4. That the velocity of sound on the kinetic theory is independent of *pressure*, is sufficiently clear at first sight; for pressure evidently could not influence the rate at which the molecules exchange motion among each other, through which means alone the impulse is conveyed.

5. That change of *specific gravity* (or molecular weight) can by itself have no effect on the velocity of the sound-wave, is evident from the fact that it cannot matter whether the molecules exchanging motion among each other (and propagating the impulse) be heavy or light, provided their velocity be the same. It has been (as is known) demonstrated, generally from dynamical principles, that a system of bodies in free collision all tend to acquire the *same* absolute energy. Hence the velocity of each body depends on its mass (or varies inversely as the square root of its mass). So the mass of the molecules of hydrogen being (as is known) one sixteenth that of the molecules of oxygen, the velocity of the molecules of hydrogen is four times greater than that of the molecules of oxygen; and accordingly *for this reason* the velocity of sound in hydrogen is exactly four times greater than its velocity in oxygen—not, however, because the molecules propagating the wave are heavy or light. The molecules of hydrogen in their normal exchange of motion, move at four times the speed (compared with those of oxygen), and therefore propagate by this exchange of motion the sound-wave at four times the speed. The specific gravity (or molecular weight) of the gas has evidently nothing whatever to do with the rate of propagation of sound. The reason why the velocity of propagation of sound *appears* to depend on the molecular weight of the gas is because the *velocity* of the molecules of the gas depends on the molecular weight.

6. So also the velocity of sound is independent of the *temperature*, provided the molecular velocity remains the same. Of course this could only be true of *different* gases (*i.e.*, of gases of different molecular weights), which—as is known—may be at different temperatures and yet possess the *same* molecular velocities. In one and the same gas of course the temperature could not be altered without altering the molecular velocity, for the "heat" itself consists in the motion of the molecules of the gas. This is therefore evidently the *cause* why the application of heat to a gas increases the velocity of sound. The addition of "heat" simply represents (as is known) the addition of velocity to the molecules of the gas, which consequently, by their exchange of motion, propagate the wave at a greater rate. The explanation of the increased velocity of sound in a heated gas is thus simple and direct. On the old theory the increased velocity of the sound-wave in a heated gas is referred to the diminished *density* of the heated gas (attendant on its expansion); and when the gas is confined, to its increased pressure. Surely this is at best a somewhat laboured and